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Bibliography of research on UTILIZATION OF SUGAR BEETS

1949 - 1965, in the Western Utilization Research and Development Division

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

IN JUNE 1965, research on sugar beet utilization in the Western Utilization Research and Development Division, Agricultural Reseach Service, U. S. Department of Agriculture, at Albany, Calif. was terminated.

This publication summarizes research on utilization of sugar beets during the period 1949 to 1965 and includes a list of publications and patents with brief abstracts. Within this Division, studies on composition of sugar beets, sugar, and processing juices were conducted in the Field Crops Laboratory and the processing studies in the Engineering and Development Laboratory.

Supervisory staff members for the sugar beet utilization research program were M. J. Copley, Director, Western Utilization Research and Development Division; W. D. Maclay and H. S. Olcott, who were formerly in charge, and G. O. Kohler, now Chief, Field Crops Laboratory; W. D. Ramage, former Chief, and A. I. Morgan, Jr., present Chief, Engineering and Development Laboratory; H. S. Owens, former Head, and R. M. McCready, recently Head of Sugar Beet Investigations.

This information was prepared in the Western Utilization Research and Development Division by R. M. McCready. A summary of progress (ARS 74-20) covering the period 1949 to 1960, was first published in May 1960 and revised in March 1961. This bibliography (ARS 74-33) covers the full period of investigation up to conclusion of the work in June 1965.

Small supplies of reprints of publications mentioned are maintained and single copies are available without charge. Those interested in reprints that are not available (*) can purchase photostat copies from the National Agricultural Library, U. S. Department of Agriculture, Washington, D. C., 20250. Copies of patents must be purchased from the U. S. Patent Office, Washington, D. C., 20231, at 50¢ each.

A copy of this publication is available from the Western Regional Research Laboratory, headquarters of the Western Utilization Research and Development Division, USDA, at 800 Buchanan St., Albany, Calif. 94710.

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Bibliography of

RESEARCH ON UTILIZATION OF SUGAR BEETS

1949-65

Research on sugar beet utilization in the U. S. Department of Agriculture at Albany, Calif., was begun in July 1948. The initial program was based on the sugar beet industry's need for (a) fundamental information on which to develop new and improved processing methods, (b) methods to predict processing characteristics of various types of beets, and (c) increased efficiency and lower cost in beet sugar manufacture.

Funds were made available through the Research and Marketing Act of 1946 for research at Albany as well as for contract research at institutions throughout the country, where facilities or scientists were best qualified for a particular project. Since 1958 selected research projects in foreign countries have been subsidized with funds made available from the sale of surplus crops under Public Law 480. Some sugar beet utilization research has been thus supported.

From the beginning, the beet sugar industry was keenly interested in the research program. An advisory committee of industry representatives (chemists and research directors) was formed to advise the Laboratory scientists on problems important to the industry. The committee, known as the Sugar Beet Process Advisory Committee, was appointed by the Beet Sugar Development Foundation, Fort Collins, Colo. Its first meeting was held in 1949. Semiannual or annual meetings were held throughout the years at the Western Regional Research Laboratory or at the biannual meetings of the American Society of Sugar Beet Technologists.

In 1957, a committee called the Sugar Beet Growers Representatives was formed to meet with Laboratory representatives to discuss progress and direction of research that would be of most value to the farmer. This committee was composed of Gordon Lyons, Executive Manager, The California Beet Growers Association, Stockton, Calif.; Loren Armbruster, Secretary, Farmers and Manufacturers Beet Growers Association, Saginaw, Mich.; Hugh M. Trowbridge, President, Red River Valley Beet Growers Association, Comstock, Minn.; and Richard W. Blake, Secretary, The National Beet Growers Federation, Greeley, Colo.

In 1954, the Beet Sugar Development Foundation made available $45,000 for purchase of pilot-scale processing equipment for all operations from washing of beets to crystallization of sugar from thick juice. In final form this processing laboratory was equipped for continuous conduct of the unit processes of diffusion, carbonation, and evaporation. Washing, slicing, mixing, filtration, second carbonation, and crystallization were batch operations. Included were a cossette cutter, a sample mixer, a diffusion battery, a continuous counter-current diffuser, a continuous liming and carbonation unit for diffusion-juice purification, a vacuum evaporator, and instrumentation for control and analysis of factory operation. Auxiliary equipment included a beet washer, an ion-exchange water conditioner, heat exchangers, continuous feeder for the diffuser, juice-cooling unit, steam-jacketed kettles for second carbonation, and filtration equipment.

Some selected examples of specific developments that have direct dollar value to the industry include the demonstration that lactic acid was produced by bacterial fermentation that used up an average of 0.2 percent of the sugar. The sugar industry immediately rectified this situation by adding more bactericide and increasing the temperature of their diffusion batteries. Other developments adopted by segments of the industry include neutralization of battery supply water to aid pulp pressing; split-stream water management to reduce salt content of processing juices introduced by well water or saving of sugar by return of pulp press water toward the head end of the diffuser; development of methods for the determination of saponin and demonstration that this substance is the primary agent responsible for floc in sugar-sweetened soft beverages. This research aided the beet industry to produce floc-free sugar and obtain its fair share of the beverage market.

Cooperative research has been conducted with almost all of the sugar companies who furnished samples of materials, advice, and often analyses to further implement the research program. Cooperation with Crops Research and other divisions of Agricultural Research Service of the Department of Agriculture has led to demonstration of the effects of beet virus yellows disease on processing, effects of nitrogen fertilization on beet quality, the fate of some insecticides during processing of sugar beets, analytical aid in developing new sugar beet varieties, and with private manufacturers, on new methods of pressing sugar beet pulp.

Some critical problems remaining in the sugar beet industry that might be solved by further utilization research include an adequate treatment of beets so that they can be held for longer periods of factory storage without sugar losses; lime treatment of cossettes prior to diffusion to improve processing; lime treatment of wet exhausted pulp to aid in its pressability; perfection of the method of ion-exclusion purification of sugar juices; concentration by reverse osmosis; and the development of a series of marketable sucrose-containing industrial products as biodegradable surfactants, ingredients in plastics, and others.

Since 1948 research that contributes to today's technology has resulted in more than 100 technical publications. This bibliography lists all references covering the work carried out in the U. S. Department of Agriculture's sugar beet utilization research program.

PROCESSING STUDIES

Processing studies were conducted under Research and Marketing Act contracts with several organizations, as well as in the industry-sponsored sugar beet processing laboratory.

PRODUCTION AND UTILIZATION OF SUGAR BEETS

H. S. Owens, C. L. Rasmussen, and W. D. Maclay
Econ. Bot. 5(4): 348-66, Oct.-Dec. 1951
This paper reviews technical phases of the development of the beet sugar industry in the United States, including breeding, production of beets, diffusion of juices in processing, purification, crystallization, Steffens process, barium process, ion exchange treatment, uses of sugar, and byproducts.

INVESTIGATION OF FACTORS INFLUENCING THE SACHS-LeDOCTE METHOD

W. D. Maclay, E. F. Potter, R. F. Erlandsen, and H. S. Owens
Amer. Soc. Sugar Beet Technol. Proc. 8(2): 298-302, 1954
Factors that might affect the accuracy of the method were examined and it was concluded that it is accurate when applied to California sugar beets.

SAMPLING OF SUGAR BEETS FOR THE PROCESSING LABORATORY

R. Teranishi, R. L. Patterson, and H. S. Owens
J. Amer. Soc. Sugar Beet Technol. 9(1): 74-7, April 1956
It was found that cossettes can be cut, mixed, and kept for 6 to 8 hours at cool temperature and thus provide an accurate sample. It is difficult to obtain a representative sample by plugging the beet root.

*INACTIVATION OF ENZYMES IN BEET COSSETTES PRIOR TO DIFFUSION

U. S. Patent No. 2,754, 233, July 10, 1956
H. S. Owens
Raw sugar beet cossettes are treated with a hot moist gas, preferably a mixture of steam and air, to rapidly inactive the enzymes in beet tissue. This permits conducting the subsequent diffusion process at lower temperature than is customary, with the result that the raw juice contains less colloidal impurities.

RECOVERY OF JUICE FROM SUGAR BEETS BY RUPTURE OF THE BEET CELLS

L. E. Brownell, S. A. Zieminski, and T. H. Lee (Univ. of Mich., Ann Arbor)
Chem. Engin. Progress 52(8): 314-18, Aug. 1956
(Contract research under Research and Marketing Act of 1946)
A report of studies of a new method involving an explosion process accomplished by steam heating and a rapid change of pressure.

*RECOVERY OF SUGAR FROM SUGAR BEETS

U. S. Patent No. 2,801,940, Aug. 6, 1957
J. B. Stark and A. E. Goodban
Carbon dioxide is added to water used in extracting sugar from beets to minimize dissolving of colloidal materials.

*PROCESSING OF SUGAR BEETS

U. S. Patent No. 2,807,560, Sept. 24, 1957
L. E. Brownell and S. A. Zieminski
(Contract research with University of Michigan under Research and Marketing Act of 1946)
Sugar beets are exposed to high pressure steam; the pressure is then suddenly released to cause rupture of the beet cells and liberation of juice therefrom. Juice is separated from the exploded mass by centrifugation or leaching with water.

THEORETICAL STEADY STATE DISTRIBUTION OF AN ADDITIVE IN SUGAR BEET DIFFUSERS

F. Stitt

J. Amer. Soc. Sugar Beet Technol. 9(7): 611-31, Oct. 1957
Theory has been developed for the steady-state distribution of a substance added continuously to any specified portion of a continuous or battery-type counter current sugar beet diffuser. It will serve as a basis for addition of substances for such purposes as control of microbiological action or of physical properties of the pulp.

*TREATMENT OF BEETS TO RELEASE JUICE

U. S. Patent No. 2, 818, 358, Dec. 31, 1957
L. E. Brownell and S. A. Zieminski
(Contract research with University of Michigan, Ann Arbor under Research and Marketing Act of 1946)
Sugar beet cossettes are introduced into a fast-moving stream of steam and then impinged on a barrier. This causes rupture of the beet cells so that the sugar-bearing juice is readily obtainable from the resulting pulp.

*MACHINE FOR PULPING SUGAR BEETS

U. S. Patent No. 2, 858, 079, Oct. 28, 1958
L. E. Brownell and S. A. Zieminski
(Contract research with University of Michigan under Research and Marketing Act of 1946)
Concerns a device for disintegrating sugar beets to form a pulp from which sugar-containing juice can be obtained by pressing or centrifuging.

*PROCESSING OF SUGAR BEETS

U. S. Patent No. 2, 873, 220, Feb. 10, 1959
L. E. Brownell and S. A. Zieminski
(Contract research with University of Michigan, Ann Arbor under Research and Marketing Act of 1946)
Concerns a device for releasing juice in sugar beet cossettes by explosive discharge of the cossettes from a region of high pressure into a region of low pressure.

EFFECTS OF SOME VARIABLES ON FIRST CARBONATION

A. I. Morgan, Jr., A. E. Goodban, R. Teranishi, R. E. Knowles, and R. M. McCready
J. Amer. Soc. Sugar Beet Technol. 10(5): 396-402, April 1959
The trends with changes in alkalinity, lime rate, and retention time are shown. The dependability of lime salts is low. The technique is satisfactory and reproducible in its final form.

*HEAT TREATMENT OF SUGAR BEET JUICE

U. S. Patent No. 2, 898, 245, Aug. 4, 1959
A. I. Morgan, Jr.
Sugar beet diffusion juice prior to liming and carbonation is subjected to a heat treatment (150-250° C. for 1/4 to 3 minutes) to reduce the foaming properties of the juice.

DEVELOPMENT OF A SUGAR BEET PROCESSING LABORATORY

A. I. Morgan, Jr., E. J. Barta, and G. O. Kohler
J. Amer. Soc. Sugar Beet Technol. 10(7): 563-70, Oct. 1959
A very small pilot plant for crystal sugar production from sugar beets has been constructed in order to measure effects of changing beet composition on processing qualities. Continuous extraction, purification, and evaporation steps were adopted. Extraction was investigated, and best results are compared with full-scale extractors.

RESEARCH ON UTILIZATION OF SUGAR BEETS--A SUMMARY OF PROGRESS 1949-1960

U. S. Dept. Agr. ARS 74-20, 16 pp., processed, May 1960 (rev. March 1961)
A report on researches at the Western Utilization Research and Development Division stimulated by processors' needs for fundamental information on new and improved processing methods, storage, and stability characteristics of various types of

beets, improvement in quality of sugar, and utilization of byproducts.

SOME EFFECTS OF VIRUS YELLOWS ON SUGAR BEET PROCESSING QUALITY

A. E. Goodban, A. I. Morgan, Jr., R. Teranishi, H. G. Walker, Jr., and R. M. McCready
J. Amer. Soc. Sugar Beet Technol.11(2): 164-67, July 1960
Yellows-affected beets gave slightly poorer thin juice, but filtration was markedly lower. Infected beets produced more soluble nitrogen than the controls.

EFFECT OF DIFFERENT DRYING CONDITIONS ON SUGAR BEET ROOTS AS A CARBOHYDRATE SOURCE FOR BROILERS

C. R. Thompson, K. W. Taylor, and G. O. Kohler
Poultry Sci. 40(1): 128-33, Jan. 1961
Sugar beet cossettes were dried under several conditions and incorporated in various chick diets. When dried quickly at high temperatures, they successfully replaced much of the carbohydrate in diets of rapidly growing chicks. Reduced gains were sometimes observed when beets dried at low temperatures were used. Similar gain reduction occurred when beets completely replaced corn. Beets also contain something which produces an increase in volume of droppings even though moisture content is not affected.

EFFECTS OF SUGAR BEET NITROGEN ON JUICE PURIFICATION

A. E. Goodban, A. I. Morgan, Jr., R. Teranishi, H. G. Walker, Jr. R. E. Knowles, and R. M. McCready
J. Amer. Soc. Sugar Beet Technol. 11(6): 533-41, July 1961
The nitrogen level in beets is related to the nitrogen fertilization and variety of beets. Characteristics affected by nitrogen level of the beet are purity, soluble nitrogen, lime salts, and sedimentation rate. All of these factors are adversely affected by increased nitrogen concentration. The level of nitrogen in juice also affects the alkalinity, but not the pH, required for optimum first carbonation.

*COUNTER CURRENT EXTRACTION PROCESSES

U. S. Patent No. 3,047,430, July 31, 1962
A. E. Goodban and J. B. Stark
A novel flow arrangement is used to obtain minimum adventitious mineral salts or maximum sugar in the water extract from sugar beets.

SALT ELIMINATION DURING DIFFUSION OF SUGAR BEETS

A. E. Goodban and J. B. Stark
J. Amer. Soc. Sugar Beet Technol. 12(3): 238-44, Oct. 1962
Diffusion water salts can be eliminated in sugar beet pulp by altering the method of introducing water to the diffuser. In a small continuous diffuser of 5.6 theoretical cells, salt elimination in the pulp is increased from 52 to 86 percent by supplying the water containing salt at the tail end and distilled water about one-third of the way forward. Increased sugar loss in the pulp by this procedure is very small. Application of a similar system to the return of pulp press water, in order to increase the amount of sugar in the juice, is also discussed.

*PROCESS FOR SEPARATING SUGARS

U. S. Patent No. 3,174,876, March 23, 1965
J. B. Stark
Sucrose is separated from glucose or other monosaccharides by ion exclusion on Dowex 50WX4 cation exchange resin. By this means both sucrose and monosaccharides can be recovered from molasses or other mixture.

THE FATE OF ALDRIN, DIELDRIN, AND ENDRIN RESIDUES DURING THE PROCESSING OF RAW SUGAR BEETS

K. C. Walker, J. C. Maitlen, J. A. Onsager, D. M. Powell, and L. I. Butler (Entomology Research Division, ARS); A. E. Goodban and R. M. McCready
U. S. Dept. Agr. ARS 33-107, 8 pp., illus., processed, Aug. 1965

Beets, grown and harvested from soils where applications of chlorinated hydrocarbon insecticides were used to control insects that attack the roots, were processed in a pilot scale beet processing laboratory. Cossettes, beet pulp, processed juices, and carbonation muds were analyzed to follow the fate of the insecticides.

BIOCHEMICAL STUDIES

In many areas of the United States an accepted and necessary practice is to harvest beets well before processing. They are then sorted in large piles at the factory or other central dump and remain in piles for as long as three months or more.

Sugar lost in factory-stored beets is one of the most serious unsolved problems in beet sugar technology. Losses are due to microbial spoilage, respiration of beets, and enzymatic and chemical changes. Some of these chemical changes produce compounds that interfere with processing. Causes of loss of sugar are neither completely understood nor under satisfactory control.

Biochemical studies have been conducted to elucidate the mechanisms by which actual sucrose losses occur.

BIOSYNTHESIS OF SUCROSE AND SUCROSE-PHOSPHATE BY SUGAR BEET LEAF EXTRACTS

E. S. Rorem, H. G. Walker, Jr., and R. M. McCready
Plant Physiol. 35(2): 269-72, March 1960

Methods for purification and assay of the enzyme fraction of sugar beet leaf tissue are described. Methods are also described for differentiation of sucrose and sucrose-phosphate formed in enzyme-substrate incubation mixtures.

COMPOSITIONAL CHANGES IN DIFFUSION JUICES FROM STORED SUGAR BEETS

H. G. Walker, Jr., E. S. Rorem, and R. M. McCready
J. Amer. Soc. Sugar Beet Technol. 11(3): 206-14, Oct. 1960

Present data indicate that beet and juice quality need not deteriorate seriously during prolonged storage, even though sucrose losses do occur. Although a cold storage environment is favorable from the standpoint of control of beet metabolism and microorganisms, it appears to promote an undesirable accumulation of raffinose.

CARBOHYDRATE METABOLISM OF SUGAR BEETS. II. CATABOLIC PATHWAYS FOR ACETATE, GLYOXYLATE, PYRUVATE, GLUCOSE AND GLUCONATE

C. H. Wang and R. D. Barbour (Oregon State College, Corvallis)
J. Amer. Soc. Sugar Beet Technol. 11(5): 443-54, 1961
(Contract research under Research and Marketing Act of 1946)

Pathways for the catabolism of acetate, glyoxylate, pyruvate, gluconate, and glucose in sugar beet roots were studied by the radiorespirametric method. Glucose is utilized mainly by way of the Embden-Meyerhof-Parnas glycolytic pathway, but partly via the phosphogluconate decarboxylation route.

CARBOHYDRATE METABOLISM OF SUGAR BEETS. I. RESPIRATORY CATABOLISM OF MONO AND DISACCHARIDES

R. D. Barbour and C. H. Wang (Oregon State College, Corvallis)
J. Amer. Soc. Sugar Beet Technol. 11(5): 436-42, April 1961
(Contract research under Research and Marketing Act of 1946)

In excised beet roots, sucrose is the major, if not exclusive, carbon source for production of respiratory CO_2. Simple carbohydrates and their derivatives such as maltose, glucose, fructose, mannose, galactose, ribose, glucuronate, and gluconate can also be catabolized by sugar beet roots.

OCCURRENCE OF THYMIDINE DIPHOSPHATE GLUCOSE PYROPHOSPHORYLASE IN YEAST

Moshe Kalina and Gad Avigad (The Hebrew University of Jerusalem, Israel)
Biochim. Biophys. Acta 73(4): 652-55, Aug. 6, 1963
(Research conducted under Public Law 480)

During a study of pathways of carbohydrate metabolism in the phosphomannan-producing yeast Hansenula capsulata NRRL Y-1842, a thymidine diphosphate D-glucose pyrophosphorylase activity was detected with D-glucose pyrophosphorylase (EC 2·7·7·9) in the cell extract.

THE UDP-GLUCOSE: D-FRUCTOSE GLUCOSYLTRANSFERASE SYSTEM FROM SUGAR BEET ROOTS

Y. Milner and G. Avigad (The Hebrew University of Jerusalem, Israel)
Proc. 34th Meeting Israel Chem. Soc., p. 316, Israel J. Chem., v. 2, 1964
(Research conducted under Public Law 480)

The UDPG: fructose transglucosylase (sucrose synthetase) is a key enzyme for sucrose synthesis and recently was suggested as being involved in the cleavage of sucrose in plant reserve tissues. The transglucosylase has now been more than 80-fold purified from sugar beet root extracts and practically freed from traces of invertase and phosphatase activities. The highly labile pure enzyme could be stabilized by reagents such as Na acetate, protamine sulfate, EDTA, and other polyamines. New procedures for a detailed kinetic assay of the system were developed.

SUCROSE METABOLISM IN PLANT STORAGE TISSUES

Gad Avigad, Naomi Levin, and Joram Milner (The Hebrew University of Jerusalem, Israel)
6th Internatl. Cong. of Biochem., New York City, July 26 to Aug. 1, 1964, Abstracts vol., 1964
(Research conducted under Public Law 480)

The current classical theory about the pathway of sucrose degradation and assimilation in plant tissues is that it occurs through a first step hydrolysis to free hexoses by sucrases which are abundantly found in the tissue extracts. Though this pathway might be operating in many cases, it cannot explain examples of sucrose assimilation in tissues poor in or devoid of invertase activity. Such cases were found in the sugar beet (Beta vulgaris) root and the Jerusalem artichoke (Helianthus tuberosis) tuber where the negligible amounts of invertase present cannot account for the rate of sucrose degradation by the respiring tissues. An alternate mechanism of sucrose utilization might be the UDP-glucose: D-fructose 2-glucosyltransferase system which was found in extracts of the beet root and in the artichoke tuber. The experimental data obtained strongly suggest that this easily reversible glucosyl transferase reaction plays a major role as a first step of sucrose degradation in the storage tissues studied.

SUCROSE-URIDINE DIPHOSPHATE GLUCOSYLTRANSFERASE FROM JERUSALEM ARTICHOKE TUBERS

Gad Avigad (Hebrew University of Jerusalem, Israel)
J. Biol. Chem. 239(11): 3613-18, Nov. 1964
(Research conducted under Public Law 480)

Sucrose-uridine diphosphate glucosyltransferase (sucrose synthetase) was obtained from Jerusalem artichoke tubers. This preparation was found convenient for kinetic studies as it was not contaminated with sucrase activity. The apparent K_m value for uridine diphosphate was found to be 3.2×10^{-4}M; for uridine diphosphate glucose, 6.4×10^{-4}M; for fructose, 1.6×10^{-3}M; and for sucrose, 3.3×10^{-2}M. The apparent equilibrium constant (k) of the reaction at pH 7.6 was found to be 1.4 to 1.8 in favor of sucrose synthesis. These findings are related to certain aspects of sucrose metabolism in plant tissues. Several convenient assay procedures for this enzyme, based on ^{14}C exchange between fructose and sucrose and on enzymatic-spectrophotometric methods, are described.

THYMIDINE DIPHOSPHATE NUCLEOTIDES AS SUBSTRATES IN THE SUCROSE SYNTHETASE REACTION

Yoram Milner and Gad Avigad (Hebrew University of Jerusalem, Israel)
Nature 206(4986): 825, May 22, 1965
(Research conducted under Public Law 480)

Although the (undine diphospho)UDP-glucose: D-fructose 2-glucosyltransferace (sucrose synthetase) is considered to be responsible for much of the synthesis of sucrose in higher plants, it has now been demonstrated that (thymidine diphospho)TDP-glucose: D-fructose 2-glucosyltransferase is active in synthesizing sucrose. TDP-glucose was also shown to be an intermediate in the synthesis of TDP-rhamnose and TDP-D-galactose which serve as glycosyl donors in the biosynthesis of complex saccharides.

COMPOSITION STUDIES

A primary need of the sugar beet industry is progressive basic research on the chemical composition of beets and beet processing liquors. Methods of analysis have never been sufficiently accurate and simple to provide the technologist with suitable means to develop new high-yielding, disease-resistant varieties or to choose the most effective processing procedures.

We have tried to adapt existing analytical procedures and develop new methods for special requirements.

ORGANIC ACIDS IN SUGAR BEET DIFFUSION JUICES

J. B. Stark, A. E. Goodban, and H. S. Owens
Proc. Amer. Soc. Sugar Beet Technol., pp. 578-83, 1950

Beet juices have been analyzed by paper chromatography of the juice and fractions of the juice separated on ion-exchange resins. Amino acids separated and identified by their growth-promoting action on bacteria were glycine, α-alanine, leucine, isoleucine, valine, glutamic acid, aspartic acid, threonine, and traces of tyrosine and phenylalanine. Organic acids identified were citric, oxalic, lactic, succinic, malic, mucic, glycolic, glutaric, and pyrrolidone carboxylic acids. Amounts were variable.

COMPOSITION OF SUGAR BEET LIQUORS. EFFECT OF PROCESSING

J. B. Stark, A. E. Goodban, and H. S. Owens
Indus. and Engin. Chem. 43(3): 603-5, March 1951

Samples of diffusion juice, thick juice, and molasses from sugar beet processing were treated with ion-exchange resins to separate the amino acids and to fractionate organic acids such as citric, oxalic, succinic, and malic. Results are presented.

PAPER CHROMATOGRAPHY OF ORGANIC ACIDS

J. B. Stark, A. E. Goodban, and H. S. Owens

Analyt. Chem. 23(3): 412-13, March 1951
In a study of identification of organic acids by paper chromatography, effects of hydration of paper, water content of solvents, temperature of development, and presence of inorganic acids on R_f values were estimated. R_f values were measured for 18 organic acids in various developing solvents.

COMPOSITION OF SUGAR BEETS

H. S. Owens, A. E. Goodban, J. B. Stark, and H. G. Walker
Sugar J. 14(2): 12-14, July 1951
Sugar beets contain a wide variety of nonsucrose constituents. Most compounds are present in negligible quantities, but certain of these (the amino and alpha-hydroxy acids) tend to go through the purification procedure and cause formation of molasses. Few compounds exist in sufficient quantities to warrant work on byproducts unless the raw material is Steffens waste liquor, in which impurities are freed of sucrose and raffinose.

RAPID METHOD FOR THE DETERMINATION OF BETAINE

H. G. Walker, Jr. and R. Erlandsen
Analyt. Chem. 23(9): 1309-11, Sept. 1951
A method for measurement of betaine in plant extracts by the use of Reinecke salt is presented. This method avoids the difficulty of isolating pure betaine reineckate. It is probably as accurate as older methods, and less time is required. It has been applied to sugar beet processing liquors with satisfactory results.

COMPOSITION OF CERTAIN BEET DIFFUSION JUICES FROM THE 1950 CAMPAIGN

J. B. Stark, A. E. Goodban, and H. S. Owens
Proc. Amer. Soc. Sugar Beet Technol., pp. 688-91, 1952
Analyses of sugar beet diffusion juices from nine factories are presented. Variations among most of the constituents were manyfold, but beet juices from the Rocky Mountain States and Michigan were low in nitrogen as compared with those obtained from Minnesota and along the Pacific Coast.

THE HYDROLYSIS RATE OF BETAINE AMIDE AND ESTER CHLORIDES

H. G. Walker, Jr. and H. S. Owens
J. Amer. Chem. Soc. 74(10): 2547-49, May 1952
The acidic and alkaline hydrolysis rates of a typical betaine ester and betaine amide have been studied. These derivatives are hydrolyzed faster in alkali and slower in acid than similar uncharged compounds.

CONDENSATION PRODUCT OF PYRROLIDONE CARBOXYLIC ACID AND FORMALDEHYDE

J. B. Stark and A. E. Goodban
J. Amer. Chem. Soc. 74(19): 4966-67, Oct. 1952
A methylene-linked derivative of pyrrolidone carboxylic acid was found in sugar beet diffusion liquors preserved with formaldehyde.

*CHEMISTRY--AN AID TO SUGAR BEET TECHNOLOGY

W. D. Maclay and H. S. Owens
The Calif. Sugar Beet, pp. 38, 39, 46,1953
A review of chemical research related to manufacture of sugar from beets.

AMINO ACIDS CONTENT OF SUGAR PROCESSING JUICES

A. E. Goodban, J. B. Stark, and H. S. Owens
J. Agr. Food Chem. 1(3): 261-64, April 1953
The amino acids in sugar beets are included in the so-called "harmful" nitrogen that is a factor in the formation of molasses in the production of beet sugar. Paper chromatography has been used to identify the amino acids in beet juices. The reflectance density of the amino acid spots developed with ninhydrin was used for quantitative estimation of the 12 amino acids found in beets.

BEET SUGARS, ACID INSOLUBLE CONSTITUENTS IN SELECTED SAMPLES

H. G. Walker and H. S. Owens
J. Agr. Food Chem. 1(6): 450-53, June 1953

Fat, various adsorbed colloidal impurities from the refined sugar, and saponin and its derivatives are reported to be present in sugar beet floc. Paper chromatography and ionophoresis were found to be useful supplementary tools for investigating the minute amounts of floc.

BEET SUGAR LIQUORS--DETERMINATION AND CONCENTRATION OF LACTIC ACID IN PROCESSING LIQUORS

J. B. Stark, A. E. Goodban, and H. S. Owens
J. Agr. Food Chem. 1(8): 564-66, July 1953
Examination has shown that cossettes contained less than 6 mg. of lactic acid per 100 g. of sucrose and that diffusion juices contained 10 to 100 times as much. Samples of liquors have been taken from various cells in continuous and batch diffusers to locate the site of possible fermentation. Results are summarized and discussed.

FRACTIONATION OF ORGANIC ACIDS IN SUGAR BEETS BY ION EXCHANGE RESINS

H. S. Owens, A. E. Goodban, and J. B. Stark
Analyt. Chem. 25(10): 1507-11, Oct. 1953
This report gives the experimental background and details for the method used at this laboratory along with results recently obtained by application of the method to sugar beet diffusion juices. It is now possible to follow the effects of processing, variety, and other agronomic factors on the organic acid content of sugar beets.

METHYLENE-BIS-(N-PYRROLIDONE-2-CARBOXYLIC ACID)

F. T. Jones, K. J. Palmer, and D. R. Black
Analyt. Chem. 25(12): 1929-30, Dec. 1953
Methylene-bis-(N-pyrrolidone-2-carboxylic acid) is a new compound found in sugar beet processing liquors. The optical and crystallographic properties of the compound reported here have been determined by the methods of chemical microscopy and X-ray diffraction. Photomicrographs of the crystals are included.

*SEPARATION OF ORGANIC ACIDS

U. S. Patent No. 2,664,441, Dec. 29, 1953
H. S. Owens, J. B. Stark, and A. E. Goodban
Organic acids are separated from one another by the use of an ion exchange bed conditioned to a particular pH to obtain a cleaner separation of the different acids upon elution of the bed.

COMPOSITION AND PERCENTAGE OF MARC IN SOME VARIETIES OF INBRED SUGAR BEETS

H. S. Owens, E. A. McComb, and G. W. Deming (Field Crops Res. Branch, Agr. Res. Serv.)
Proc. Amer. Soc. Sugar Beet Technol. 8(2): 267-71, 1954
Analyses, including sucrose, marc, and water-soluble polysaccharide contents, of 15 inbred varieties of sugar beets are reported.

LACTIC ACID FERMENTATION IN BEET PROCESSING JUICES

J. B. Stark, A. E. Goodban, and H. S. Owens
Proc. Amer. Soc. Sugar Beet Technol. 8(2): 227-31, 1954
Lactic acid concentrations in cossettes, diffusion juice, thick juice, and molasses were compared. Lactic acid is formed during diffusion, probably by fermentation. Increasing temperature of battery supply water markedly decreases the fermentation.

APPLICATION OF COMPOSITIONAL KNOWLEDGE TO BEET SUGAR TECHNOLOGY

H. S. Owens, J. B. Stark, A. E. Goodban, and H. G. Walker, Jr.
J. Agr. Food Chem. 3(4): 350-53, April 1955
Investigations of the composition of beets and their processing liquors have been under way for about 5 years. Results of these studies and their significance in beet technology are reviewed.

DETERMINATION OF SAPONINS IN REFINED BEET SUGARS

H. G. Walker, Jr.
J. Amer. Soc. Sugar Beet Technol. 9(3): 233-37, Oct. 1956
The method is based on the reaction of sugar beet saponins with antimony pentachloride to produce a red complex with absorption maximum at 535 mμ. It meets the need for control work, since large numbers of samples can be analyzed in a short time.

THE PURINES, PYRIMIDINES, AND NUCLEOSIDES IN BEET DIFFUSION JUICE AND MOLASSES

J. B. Stark, T. Jaouni, and G. F. Bailey
J. Amer. Soc. Sugar Beet Technol. 9(3): 201-6, Oct. 1956

As a continuation of work on composition of sugar beet liquors the presence of purines, pyrimidines, and nucleosides was investigated and in some cases the quantities were determined.

RAPID METHOD FOR DETERMINATION OF MALIC ACID

A. E. Goodban and J. B. Stark
Analyt. Chem. 29(2): 283-87, Feb. 1957

Malic acid is separated from other materials by means of ion-exchange resins and determined colorimetrically after reaction with 2,7-naphthalenediol and H_2SO_4.

ABSENCE OF CARBONATE IN BEET MOLASSES

J. B. Stark and H. M. Wright
J. Amer. Soc. Sugar Beet Technol. 9(7): 566-67, Oct. 1957

None of the 12 molasses samples tested showed more than 0.07 percent carbonate and within the limits of accuracy of the method, no carbonate was detected.

A METHOD FOR CHARACTERIZATION OF PECTIC SUBSTANCES IN SOME FRUIT AND SUGAR BEET MARC

M. Gee, E. A. McComb, and R. M. McCready
Food Res. 23(1): 72-5, Jan.-Feb. 1958

Total pectic substances as anhydrouronic acid, degree of esterification, and acetyl can be obtained by direct analysis of marc without isolating and purifying the pectic materials, provided it has first been established that total pectic substances calculated by this method agree with results determined by some other method such as the carbazole method.

QUANTITATIVE DETERMINATION OF RAFFINOSE OR MELIBIOSE BY PAPER CHROMATOGRAPHY

A. Bevenue and K. T. Williams
Arch. Biochem. Biophys. 73(2): 291-95, Feb. 1958

This paper presents a modified procedure for preparation and application of the chromogenic reagents used in locating and measuring sugar spots on paper chromatograms, which contributes to increased simplicity of operation and greater precision in quantitative determination of raffinose measured as melibiose.

ULTRAVIOLET FLUORESCENCE OF QUININE SULFATE FOR DETECTION OF PHOSPHATE ESTER SPOTS ON PAPER

E. S. Rorem
Nature 183(4677): 1739-40, June 1959

The phosphate spots are located by immersing the developed and dried paper in a solution of 0.5 percent quinine sulfate in absolute ethanol. After drying at room temperature for a few minutes, the phosphate spots can be detected by examining the paper under ultraviolet light in a darkened room. Interfering materials, such as free sugars and amino acids, must be present in relatively high concentrations before they are detected under UV light. Spots containing as little as 0.007 μ moles of phosphorous can be detected.

MULTIPLE SAMPLE, CONTINUOUS DIALYZER

J. B. Stark
Chemist-Analyst 48(1): 17, March 1959

Samples (alike or different) in seamless cellophane bags are placed in a bottle fitted with a rotating vacuum bearing. The whole apparatus is rotated on mechanical rollers while water flows in and out of the bottle through the vacuum bearing assembly.

*SEPARATION OF NITROGENOUS ORGANIC COMPOUNDS

U. S. Patent No. 2,891,945, June 23, 1959
J. B. Stark

Compositions containing purines, pyrimidines, nucleosides, and amino acids are separated into their components by an ion exchange technique.

RAPID DETERMINATION OF MOISTURE IN PRESSED SUGAR BEET PULP

A. E. Goodban, T. Jaouni, and R. M. McCready

J. Amer. Soc. Sugar Beet Technol. 10(6): 478-80, July 1959
The solids content of sugar beet pulp can be estimated by the dichromate heat-of-dilution method. The method has been used for determination of moisture in other plant materials and is suitable for use on sugar beet pulp. Precision and accuracy compare well with oven methods, and determination can be made in 10 minutes.

FRACTIONATION OF NITROGEN COMPOUNDS IN BEET MOLASSES

J. B. Stark, A. E. Goodban, and R. M. McCready
J. Amer. Soc. Sugar Beet Technol. 10(7): 571-77, Oct. 1959
Samples of molasses were obtained from nine beet sugar factories. Nitrogen determinations were made on various fractions (basic, acidic, and unabsorbed) as separated by ion-exchange resins. Information is presented on known as well as unidentified nitrogen compounds.

PARTIAL COMPOSITION OF SUGAR BEET MOLASSES

J. B. Stark, A. E. Goodban, and R. M. McCready
J. Amer. Soc. Sugar Beet Technol. 10(7): 651-56, Oct. 1959
Analyses are reported for 12 constituents of molasses from 9 factories and the relative importance of the constituents is discussed.

MEASUREMENT OF PLANT ACIDS. DETERMINATION OF AVERAGE EQUIVALENT WEIGHT AND TOTAL WEIGHT OF PLANT ACIDS BY ION EXCHANGE RESINS APPLIED TO SUGAR BEET MOLASSES

J. B. Stark
J. Agr. Food Chem. 8(3): 234-36, May-June 1960
A method is presented for determination of the average equivalent weight of the anions present in plant extracts. The equivalents of acid and the total weight of acid are also determined.

ULTRAVIOLET FLUORESCENCE FOR DETECTION OF ORGANIC COMPOUNDS ON PAPER

Edward S. Rorem
J. Chromatog. 4(2): 162-65, Aug. 1960
A procedure utilizing solutions of quinine sulfate $\cdot 2H_2O$ in absolute ethanol or sulfosalicylic acid in acetone has been developed for the nonselective detection of organic compounds on paper chromatograms. When developed and dried papers are dipped in appropriate solution, dried, and observed under ultraviolet light, organic compounds are visible against the background fluorescence of the paper.

*SEPARATION OF NITROGENOUS ORGANIC COMPOUNDS

U. S. Patent No. 2,949,450, Aug. 16, 1960
J. B. Stark
Salts of purines, pyrimidines, nucleosides, etc. are converted into the corresponding free bases by a process which involves absorption on an anion exchanger followed by elution with an aqueous solution of carbon dioxide.

ULTRAVIOLET FLUORESCENCE OF SULFOSALICYLIC ACID FOR THE DETECTION AND DIFFERENTIATION OF KETOSES AND ALDOSES

Edward S. Rorem
Analyt. Biochem. 1(3): 218-20, Nov. 1960
Chromatograms are dipped in sulfosalicylic acid in acetone and dried. Under ultraviolet light many organic compounds can be detected and marked. When heated only ketoses develop a tan color, which is amplified under ultraviolet light.

PLANT PECTIN ANALYSIS. DETERMINATION OF PECTIC SUBSTANCES BY PAPER CHROMATOGRAPHY

R. M. McCready and Mildred Gee
J. Agr. Food Chem. 8(6): 510-13, Nov.-Dec. 1960
Physical methods of purification of several fruit and vegetable pectinic acids resulted in polymers containing nonuronide sugar units. Nonuronide sugars appear to be incorporated

into the galacturonan molecule of pectic substances from most plant materials.

THE COMPOSITION OF BEET MOLASSES WITH PARTICULAR REFERENCE TO NITROGENOUS COMPOUNDS

J. B. Stark

J. Amer. Soc. Sugar Beet Technol. 11(6): 507-14, July 1961

The differences in composition of straight house and Steffen beet sugar molasses are presented and discussed. An ion exchange procedure is described that can be used to separate a number of nitrogen compounds found in molasses or in water extracts of other plant products.

SOME CHEMICAL-GENETIC STUDIES PERTAINING TO CUALITY IN SUGAR BEETS (*BETA VULGARIS L.*)

Merle G. Payne, LeRoy Powers, and E. E. Remmenga

J. Amer. Soc. Sugar Beet Technol. 11(7): 610-28, Oct. 1961

(Cooperative research by Colo. Agr. Expt. Sta., Ft. Collins; U.S. Dept. Agr.; and Beet Sugar Devel. Found.)

The use of fertilizer increased the concentration of total nitrogen, betaine, and glutamic acid. Sucrose concentration was found to decrease in three of the six populations used, indicating a genotype environmental interaction.

THE VARIABILITY OF SUGAR BEET CONSTITUENTS AS INFLUENCED BY YEARS, LOCATION, VARIETY AND NITROGEN FERTILIZATION

D. R. McAllister, Rex L. Hurst, D. G. Wooley, Harold M. Nielsen, L. Elmer Olson, D. A. Greenwood, H. M. LeBaron, and W. H. Bennett (Utah Agr. Expt. Sta., Logan)

J. Amer. Soc. Sugar Beet Technol. 11(7): 547-64, Oct. 1961

(Contract research under Research and Marketing Act of 1946)

The following constituents were studied: marc, sucrose, total and amino nitrogen, total glutamate, total anionic constituents, moisture, malic and oxalic acid, raffinose, and galactinol. Data from three crop years were reported.

A TEST PAPER FOR THE DETECTION OF GALACTOSE AND CERTAIN GALACTOSE-CONTAINING SUGARS

Edward S. Rorem and J. C. Lewis

Analyt. Biochem. 3(3): 230-35, March 1962

A procedure is described for the preparation of crude freeze-dried galactose oxidase from the growth medium of the fungus *Polyporus circinatus* Fr. to be used for making test papers specific for galactose, raffinose, stachyose, and certain other galactose-containing sugars. The enzyme galactose oxidase catalyzes the oxidation of carbon-6 of galactose or galactose moiety of certain oligosaccharides from an alcohol to an aldehyde. The test papers are useful for semiquantitative screening. Ion exchange methods are described for the elimination of the interfering compounds--ascorbic acid, chlorides, and fluorides.

*SEPARATION OF NITROGENOUS ORGANIC COMPOUNDS

U. S. Patent No. 3,015,655, Jan. 2, 1962

J. B. Stark

Mixtures containing such compounds as purines, pyrimidines, nucleosides, and amino acids are separated into their components by an ion exchange technique.

USE OF ION-EXCHANGE RESINS TO CLASSIFY PLANT NITROGENOUS COMPOUNDS IN BEET MOLASSES

J. B. Stark

Analyt. Biochem. 4(2): 103-9, Aug. 1962

This method may be used to determine nitrogen distribution, to remove undesirable substances prior to other chromatographic procedures, and to isolate specific compounds. It has been used to determine quantitative variations of different classes of nitrogenous compounds in sugar beet molasses and should prove valuable in survey studies of the composition of other plant materials.

*MEANS FOR DETECTING GALACTOSE

U. S. Patent No. 3,066,081, Nov. 27,1962
E. S. Rorem and J. C. Lewis
Describes an analytical implement comprising paper impregnated with galactose-oxidase, peroxidase, and ortho-tolidine. On contact with galactose a blue color is developed.

CHEMICAL GENETIC AND SOILS STUDIES INVOLVING THIRTEEN CHARACTERS IN SUGAR BEETS

LeRoy Powers, W. R. Schmehl, W. T. Federer and Merle G. Payne
J. Amer. Soc. Sugar Beet Technol. 12(5): 393-448, April 1963
(Cooperative research by Colo. Agr. Expt. Sta., Ft. Collins; U. S. Dept. Agr.; and Beet Sugar Devel. Found.)
The important agronomic characters studied were weight per root, percentage sucrose, and percentage apparent purity. Studies with the thin juice were made of total N, glutamic acid, betaine, K, Na, and Cl; with petioles, of nitrate N, P, K, and Na. The interrelations of the variables with phenotype dominance, dates of harvest, and combining ability were determined by a study of means and of correlation coefficients.

METHYL α-FURANOSIDE DERIVATIVES OF FULLY METHYLATED GALACTOSE AND GALACTURONIC ACID

H. G. Walker, Jr. and R. M. McCready
Canad. J.of Chem. 41(12): 3134-35, Dec. 1963
Confirmation by chemical means of the furanose structure of the products of direct methylation of D-galactose or D-galacturonic acid by the Kuhn procedure.

EFFECT OF GENETIC POPULATION AND SOIL FERTILITY LEVEL ON THE CHEMICAL COMPOSITION OF SUGAR BEET TOPS

R. H. Follett, W. R. Schmehl, LeRoy Powers, and Merle G. Payne
Colo. State Agr. Expt. Sta. Tech. Bull. 79, 65 pp., illus, April 1964
(Cooperative research by Colo. Agr. Expt. Sta., Ft. Collins; U. S. Dept. Agr.; and Beet Sugar Devel. Found.)
The application of nitrogen fertilizer did not significantly affect root yield, sucrose per acre, calcium or magnesium content of the petioles or sodium, calcium, magnesium, or total cations in the blades. But the application of both nitrogen and phosphorus fertilizer produced a significant increase in yield. Nitrogen fertilizer increased nitrate nitrogen and total nitrogen in the petioles and blades as well as sodium and total cations in the petioles but decreased sucrose percentage of root, total phosphorus in petioles, and potassium in petioles and blades. There were significant differences among populations for all characters studied, except total phosphorus in the petioles. Although sodium and potassium were strongly associated with sucrose, they were apparently not the causative factors for low or high sucrose. The petioles contained the larger amounts of nitrate nitrogen and the blades contained the larger amounts of total nitrogen, phosphorus, potassium, calcium, magnesium, and total cations. Sodium content was about equal in the petioles and blades. The concentrations of minerals in the plant tissue depended considerably upon the genetic population under consideration. The sugar beets grown under three fertility levels in this experiment tended to maintain constant sums of cations in the blades and, to a slightly lesser extent, in the petioles.

ASSOCIATION OF LEVELS OF TOTAL NITROGEN, POTASSIUM, AND SODIUM IN PETIOLES AND IN THIN JUICE WITH WEIGHT OF ROOTS PER PLOT, PERCENTAGE SUCROSE AND PERCENTAGE APPARENT PURITY IN SUGAR BEETS

LeRoy Powers and Merle G. Payne
J. Amer. Soc. Sugar Beet Technol. 13(2): 138-50, July 1964
(Cooperative research by Colo. Agr. Expt. Sta., Ft. Collins; U. S. Dept. Agr.; and Beet Sugar Devel. Found.)
Increases of total N in the petioles

rather than in the thin juice can result in an increase in weight per plot, percent sucrose, and percent apparent purity. Weight of roots per plot, percent sucrose, and percent apparent purity in some populations are favorably associated with total N in the petioles, but not with total N in the thin juice. It is more desirable to have higher levels of K, Na, and P in the petioles than in the thin juice for the production of higher yields.

LEVELS OF TOTAL NITROGEN, POTASSIUM AND SODIUM IN PETIOLES AND IN THIN JUICE OF SUGAR BEETS

Merle G. Payne, LeRoy Powers, and Grace W. Maag
J. Amer. Soc. Sugar Beet Technol. 13(2): 127-37, July 1964
(Cooperative research by Colo. Agr. Expt. Sta., Ft. Collins; U.S. Dept. Agr.; and Beet Sugar Development Foundation)

Populations of sugar beets were found to differ in the relative levels of total N, K, and Na in the petioles as compared with levels of the same chemicals in the thin juice. The interactions involving genotypes vs. materials analyzed (petioles or thin juice) showed that, at the time of harvest, higher levels of the three elements occur in either the petioles or the thin juice, or in both. Conversely, at harvest time, some genotypes have higher levels of these three elements in the petioles associated with lower levels of the thin juice. The results indicate that populations can be bred that will have higher levels of these elements in the tops (petioles) of the sugar beet than in the roots (thin juice).

PAPER CHROMATIGRAPHIC DETERMINATION OF RAFFINOSE IN SUGAR BEET MOLASSES

Fern Jantzef and A. L. Potter
J. Amer. Soc. Sugar Beet Technol. 13(3): 218-24, Oct. 1964

A paper chromatographic determination of raffinose in sugar beet molasses was developed. The treatment of the sample before chromatography is simple. Two clarification procedures are required: (a) treatment with lead acetate; (b) treatment with lead acetate followed by washing the sugars through a cellulose powder column with 80 percent ethanol. Each procedure gave the same raffinose values. The sugars were separated by descending chromatography. p-Anisidine was chosen to develop the color of the raffinose spots because it is as sensitive as other reagents tested and produces more stable color. The intensity of the color of the spots was measured with a color difference meter or a transmission densitometer.

GAS LIQUID CHROMATOGRAPHIC ANALYSIS OF SUGAR BEET MOLASSES CARBOHYDRATE DERIVATIVES

H. G. Walker, Jr.
Internatl. Sugar J. 67: 237-39, 1965

Mixtures of the neutral carbohydrate components in a number of beet molasses samples have been isolated by an ion-exchange treatment of diluted molasses followed by freeze drying. Both chemical analysis and thin layer chromatography indicated that no inversion or other change in the sugars was induced by the ion-exchange treatment. The sugar mixtures were converted to their trimethyl silyl derivatives and subjected to gas liquid chromatographic analysis. Excellent qualitative separation of all components except raffinose and the kestoses was obtained. In most cases the amounts of non-sucrose carbohydrates in the samples were so small compared with the amounts of sucrose present that highly accurate quantitative results could not be obtained.

SUGAR RESEARCH

Studies were conducted on some of the fundamental properties of sucrose and its constituent sugars, glucose and fructose. Methods of analyses, detection, crystallization, and reaction to form potentially useful derivatives have been described.

SUCROSE HYDRATES; THE SUCROSE-WATER PHASE DIAGRAM

F. E. Young and F. T. Jones
J. Phys. and Colloid Chem. 53(9): 1334-50, Dec. 1949

The sucrose-water system has been investigated by warming curves, solubility measurements, and microscopy. Two crystalline hydrates of sucrose have been isolated and identified as sucrose hemipentahydrate ($C_{12}H_{22}C_{11} \cdot 2\text{-}1/2H_2O$) and sucrose hemiheptahydrate ($C_{12}H_{22}O_{11} \cdot 3\text{-}1/2\ H_2O$). Two additional solid phases have been isolated and indications of several more have been obtained.

PREVENTION OF THE GROWTH OF SUCROSE HYDRATES IN SUCROSE SIRUPS

F. E. Young, F. T. Jones, and H. J. Lewis
Food Res. 16(1): 20-29, Jan.-Feb. 1951

Growth of sucrose hydrate in sucrose sirups was repressed by storage at -30° F.; it was also repressed at -10° F. by replacement of a portion of the sucrose by corn sirup, invert sugar, maltose, or levulose. Frequent spontaneous crystallization of dextrose would prevent its use as sucrose hydrate inhibitor.

D-FRUCTOSE DIHYDRATE

F. E. Young, F. T. Jones, and H. J. Lewis
J. Phys. Chem. 36(6): 738-39, June 1952

The discovery, preparation, and properties of a new crystalline dihydrate of β-D-fructose are described.

D-FRUCTOSE HEMIHYDRATE

F. E. Young, F. T. Jones, and D. R. Black
J. Amer. Chem. Soc. 74(22): 5798-99, Nov. 1952

Fine metastable needles crystallized from D-fructose solutions are shown to be fructose hemihydrate rather than a dimorph of anhydrous D-fructose as has been suggested. The preparation, properties, optical crystallographical, and X-ray diffraction data for D-fructose hemihydrate are given.

D-FRUCTOSE-WATER PHASE DIAGRAM

F. E. Young, F. T. Jones, and H. J. Lewis
J. Phys. Chem. 56(9): 1093-96, Dec. 1952

The D-fructose-water system has been studied between -30° and 40° C. Well defined crystalline phases studied include anhydrous D-fructose, stable above 21.4° C.; D-fructose hemihydrate stable between 21.4° and 19.9° C.; data are given for a crystalline phase, which appears to be a metastable form of D-fructose dihydrate. A D-fructose gel is described and the approximate range of solution concentrations in which it can exist have been determined between -20° and 10° C.

OPTICAL AND CRYSTALLOGRAPHIC PROPERTIES OF D-FRUCTOSE HEMIHYDRATE

F. T. Jones, F. E. Young, and D. R. Black
Analyt. Chem. 25(4): 649, April 1953

Refractive indices, crystal morphology, and X-ray powder data are given for D-fructose hemihydrate.

OPTICAL AND CRYSTALLOGRAPHIC PROPERTIES OF SUCROSE HEMIHEPTAHYDRATE

F. T. Jones and F. E. Young
Analyt. Chem. 26(2): 421, Feb. 1954

The composition and optical and crystallographic properties of sucrose hemiheptahydrate crystals grown at -7.5° C. are reported as determined by the methods of chemical microscopy.

D-FRUCTOSE 2, 4-DINITROPHENYL HYDRAZONE PYRIDINE SOLVATE

F. T. Jones, D. R. Black, and L. M. White
Analyt. Chem. 27(7): 1203-4, July 1955
Data on morphology, X-ray diffraction, and optical properties of the crystals are reported.

SUGAR CRYSTALLIZATION. EQUILIBRIUM MOISTURE CONTENT AND CRYSTALLIZATION OF AMORPHOUS SUCROSE AND GLUCOSE

B. Makower and W. B. Dye
J. Agr. Food Chem. 4(1): 72-7, Jan. 1956
Uptake of water vapor and extent of crystallization were determined in amorphous (metastable) sucrose and glucose powders exposed to relative humidites from 4. 6 to 33. 6 percent at 25°C. With data obtained and with published results, a complete equilibrium humidity isotherm for sucrose-water solutions from 0 to 100 percent sucrose at 25°C. was constructed.

SUGAR CRYSTALLIZATION. X-RAY DIFFRACTOMETER AND MICROSCOPIC INVESTIGATION OF CRYSTALLIZATION OF AMORPHOUS SUCROSE

K. J. Palmer, W. B. Dye, and D. R. Black.
J. Agr. Food Chem. 4(1): 77-81, Jan. 1956
An X-ray method has been developed for determining the crystalline-to-amorphous ratio in spray-dried sucrose. Observations made with a polarizing microscope were used with other evidence to postulate a mechanism for the crystallization process.

D-FRUCTOSE 2, 4-DINITROPHENYL HYDRAZONE DIOXANE SOLVATE

F. T. Jones, D. R. Black, and L. M. White
Analyt. Chem. 28(2): 268-69, Feb. 1965
Data on morphology, X-ray diffraction, and optical properties of the crystal are reported.

CRYSTALLIZATION OF SUCROSE WITH SONIC WAVES

A. Van Hook, W. F. Radle, J. E. Bujake, and J. J. Casazza (College of the Holy Cross, Worcester, Mass.)
J. Amer. Soc. Sugar Beet Technol. 9(7): 590-95, Oct. 1957
(Contract research under the Research and Marketing Act. of 1946)
Studies on the graining of sucrose sirups by sonic waves are reported. The graining mechanism by the sonic activity is heterogeneous and not homogeneous. Treatment with sonic waves accelerates the adjustment of supersaturated solutions, both pure and impure. The effects of sonic graining become more pronounced with increasing supersaturation and time of irradiation.

A STUDY OF SUCROSE CRYSTALLIZATION BY THE DILATOMETRIC METHOD

H. G. Walker, Jr., Roy Teranishi, R. E. Knowles, G. O. Kohler, and R. M. McCready
Proc. 10th Congress, Internatl. Soc. Sugarcane Technol., pp. 270-77, 1959
A dilatometric method for the study of sucrose crystallization rates is described. The problem of the interpretation of rate data obtained by this method for pure and impure sucrose solutions is discussed.

*LONG-CHAIN DERIVATIVES OF MONOSACCHARIDES AND OLIGOSACCHARIDE

G. R. Ames (Tropical Products Inst., London)
Chem. Reviews 60(6): 541-53, Dec. 1960
(Research conducted under Public Law 480)
A review and bibliography, with brief descriptions of methods of preparation and some properties of long-chain derivatives of mono- and oligosaccharides.

GAS CHROMATOGRAPHIC ANALYSIS OF SUCROSE MONOSTEARATE

Mildred Gee and H. G. Walker, Jr.
Chem. and Indus. 24: 829-30, June 17, 1961

Gas chromatographic examination of methylated saponified methanolized sucrose monostearate showed esterification occurred predominantly on the primary hydroxyl of the glucose moiety.

LONG-CHAIN DERIVATIVES OF SUGARS. I. SOME REACTIONS OF N-OCTADECYL-D-GLUCOSYLAMINE

G. R. Ames and T. A. King (Tropical Prod. Inst., London)

J. Org. Chem. 27: 390-95, 1962

(Research conducted under Public Law 480)

The reaction of N-octadecyl-D-glucosylamine (I) with chloroacetic acid in pyridine gives rise to a hydrochloride, probably the iminium salt, which is converted by alkali into 1-deoxy-1-N-octadecylamino-D-fructose (II), isomeric with I. The formation of II is equivalent to an Amadori rearrangement of I, and these reactions provide evidence on the mechanism of the Amadori rearrangement. Both the isomers I and II lose water on treatment with alkali.

GAS-LIQUID CHROMATOGRAPHY OF SOME METHYLATED MONO-, DI-, AND TRISACCHARIDES

Mildred Gee and H. G. Walker, Jr.

Analyt. Chem. 34(6): 650-53, May 1962

The use of 2-mm. i.d. packed columns with 5 to 10 percent polar liquid phase concentrations permits rapid analysis and good separation of complex methylated sugar mixtures. Use of gas-liquid chromatography provides a more rapid and complete estimation of the position of various linkages present in carbohydrates than has been possible by other means.

COMPLETE METHYLATION OF REDUCING CARBOHYDRATES

H. G. Walker, Jr., Mildred Gee, and R. M. McCready

J. Org. Chem. 27(6): 2100-02, June 1962

Reducing carbohydrates can be completely methylated in a single step in good yield with silver oxide and methyl iodide in dimethyl formamide. The ring structure and conformation of the principal glycosidic product obtained depends on the sugar used.

THIN-LAYER CHROMATOGRAPHY OF SUCROSE ESTERS AND MIXTURES OF RAFFINOSE AND SUCROSE

Mildred Gee

J. Chromatog. 9(3): 278-82, Nov. 1962

The technique of qualitative and quantitative silica gel chromatography on glass strips has been adapted to separate mixtures of sucrose esters, and sucrose with raffinose. Solvent mixtures are described which give rapid, definitive separations of these compounds. The separated components can be eluted from the silica gel and measured for sucrose content by the colorimetric procedure of Roe.

THIN-LAYER CHROMATOGRAPHY OF SOME METHYLATED GLYCOSIDES

Mildred Gee

Analyt. Chem. 35(3): 330-53, March 1963

Thin-layer chromatography on silica gel serves to separate anomers and isomers of methylated sugar glycosides. The area on the developed and dried plates occupied by the sugar derivative was revealed by spraying with dilute sulfuric acid and charring at 110°C. The entire procedure requires about 1 hour.

THE OPTICAL AND X-RAY CRYSTALLOGRAPHIC PROPERTIES OF SUCROSE · CALCIUM CHLORIDE · TETRAHYDRATE

F. T. Jones, E. S. Rorem, and K. J. Palmer

Microscopy & Crystal Front 13(12): 346-50, May-June 1963

A new compound, sucrose · calcium chloride · tetrahydrate, is described. It was discovered during attempts to extract sucrose from beet molasses. Photomicrographs and drawings show the morphology, and optical and crystallographic properties based on refractive indices and X-ray diffraction. Tables of data are included.

ALKYLOXYMETHYL ETHERS OF SUCROSE AND GLUCOSE AS SURFACTANTS

G. R. Ames, Hazel M. Blackmore, and T. A. King (Tropical Prod. Inst., London)
J. Appl. Chem. 14(6): 245-49, June 1964
(Research conducted under Public Law 480)

Alkyl chloromethyl ethers react with excess of sucrose in dimethyl formamide solution to give under suitable conditions, mono- and dialkyloxymethyl ethers. Certain of these compounds have shown a high degree of surface activity and in the presence of conventional builders, of detergency. In laboratory detergency tests they were more effective than sodium dodecylbenzenesulphonate. The properties of some glucose alkyloxymethyl ethers also are reported.

REVERSED-PHASE PAPER CHROMATOGRAPHY OF SOME SUBSTITUTED HYDRAZINE DERIVATIVES OF MONOSACCHARIDES AND RELATED COMPOUNDS

Geraldine E. Secor and Lawrence M. White
J. Chromatog. 15(1): 111-15, June 1964

A reversed-phase Zaffaroni-type solvent system used for the paper chromatography of steroids gave rapid and satisfactory resolution of substituted hydrazine derivatives of monosaccharides and some organic acids and lactones. A number of systems of this general type were screened with typical sugar hydrazones and osazones. This paper reports the separations obtained with the best of these solvent systems--formamide-ethyl acetate-water (1:20:1) and formamide-impregnated paper.

THE REACTION OF SUGARS WITH ALKYL HALOGENOMETHYL ETHERS

G. R. Ames, Hazel M. Blackmore, a and T. A. King (Tropical Prod. Inst., London)
J. Appl. Chem. 14(11): 503-6, Nov. 1964
(Research conducted under Public Law 480)

Alkyl chloromethyl ethers react readily with sugars in DMF solution only in the absence of a base, even though the reaction produces an acid-labile acetal and hydrogen chloride. The effect on the reaction of variations in the alkyl group, halogen, sugar, solvent, temperature, and reaction time is described.

SUGAR DETERMINATION IN GREEN AND LEAFY PLANTS AND DRIED FORAGES

Earl F. Potter and Marion C. Long
J. Assoc. Off. Agr. Chem. 48(4): 728-30, Aug. 1965

The ion-exchange resin method is superior for clarifying extracts of green and leafy plants and dried forages. The principal sugars present should be determined by the micro Shaffer-Somogyi method.

ISOPROPYL ALCOHOL EXTRACTION OF FREE SUGARS FROM PLANT MATERIALS

Earl F. Potter
J. Assoc. Off. Agr. Chem. 48(4): 717-18, Aug. 1965

At the present the free sugars of plant material are extracted with ethyl alcohol. Experimental data show that this may be replaced with isopropyl alcohol.

BYPRODUCT RESEARCH

In the sugar beet industry, sugar is the main cash product, but byproducts also have great value. Growers sell beet tops for feed, and processors sell molasses and beet pulp. Experiments were conducted on beet byproducts and on beets processed for feed.

SUGAR BEET TOP FOOD VALUE SAVED BY MECHANICAL METHODS

R. D. Barmington, L. E. Jenneke, and D. M. Stevens (Colo. Agr. Expt. Sta., Ft. Collins)
Colo. A & M News 6(1): 6-8, July 1951
(Contract research under Research and Marketing Act of 1946)
Experiments and cost studies were conducted on dehydration of sugar beet tops (both field stripped and whole tops).

CONSERVATION OF SUGAR BEET TOPS BY DEHYDRATION

R. D. Barmington, P. N. Davis, and H. S. Wilgus
Colo. Agr. Expt. Sta. Tech. Bull. 47, 1952
(Contract research under Research and Marketing Act of 1946)
This bulletin reports studies of nutritive components of beet tops and leaves and the effect of fertilization, mechanical harvesting and dehydration on these components. Feeding tests and the economics of utilizing beet top and leaves are covered.

ISOLATION AND PROPERTIES OF SUGAR BEET ARABAN

A. E. Goodban and H. S. Owens
J. Amer. Soc. Sugar Beet Technol. 9(2): 129-32, July 1956
Araban must be considered in the processing of sugar beets, especially in sedimentation of lime muds and crystallization of sucrose. It has been isolated from pulp by extraction with lime water and purified by fractionation as the diacetate on a carbon column.

CHROMATOGRAPHIC FRACTIONATION OF SUGAR BEET ARABAN

A. E. Goodban and H. S. Owens
J. Polymer Sci. 23(104): 825-29, Feb. 1957
Sugar beet araban acetate has been fractionated by precipitation and by chromatography. Chromatography offered the better means of increasing the purity of the araban acetate.

*ISOLATION OF ARABAN FROM SUGAR BEET PULP

U. S. Patent No. 2, 803, 567, Aug. 20, 1957
H. S. Owens and A. E. Goodban
Araban is isolated from beet pulp by a process which includes digesting the pulp with lime, precipitation of impurities from the resulting liquor by addition of CO_2, and evaporation of the purified liquor.

MOLECULAR WEIGHTS OF SUGAR BEET ARABAN FRACTIONS

Y. Tomimatsu, K. J. Palmer, A. E. Goodban, and W. H. Ward
J. Polymer Sci. 36(130): 129-39, April 1959
The molecular weight of sugar beet araban fractions prepared by fractionation of araban acetates on a charcoal column has been determined. No simple relationship between molecular weight and fraction number was observed and most of the fractions showed appreciable molecular weight heterogeneity.

LIGHT-SCATTERING STUDIES ON SUGAR BEET ARABANS

Yoshio Tomimatsu and K. J. Palmer
J. Polymer Sci., Part A, 1: 1005-14, 1963
The discrepancy in the molecular weight measurements of sugar beet araban by light-scattering in two solvent systems, 2M NaCl and 1 percent (v/v)N, N-dimethylformamide (DMF), is explained on the basis of a charge effect in the latter solvent. Molecular weight measurements on araban acetate prepared for purification purposes indicated considerable degradation during deacetylation.

USES FOR SUGAR BEET PULP
R. M. McCready and A. E. Goodban
J. Amer. Soc. Sugar Beet Technol. 13(5): 467-68, April 1965

Processing hints are presented so that beet pulp might be utilized for its pectin, araban, galactan, and cellulose contents in non-feed uses such as a thickening agent or a component of pressed board.

UNPUBLISHED ARTICLES

Because research on sugar beet utilization has been terminated and a few articles reporting research have been submitted for outside journals but are unpublished as of this date, the title and author are listed below for the reader's convenience. Copy of each manuscript is on file in the Western Utilization Research and Development Division, ARS, USDA, 800 Buchanan St., Albany, Calif., 94710.

Processing Studies

CHANGES IN SUGAR EXTRACTION OVER TWO DECADES
J. B. Stark and A. E. Goodban

Changes in sugar extraction are primarily due to changes in sugar content of beets and purity of thin juice. Factories showing no change in these factors show little or no change in sugar extraction.

AN ENGINEERING ANALYSIS OF ION EXCLUSION
W. G. Schultz, J. B. Stark, and E. Lowe

Rates for sucrose and waste recovery from beet molasses were mathematically correlated with the process variables: temperature, column height, flow rate, feed concentration, and volume of loading. Longevity trials with beet and cane molasses show it is necessary to consider filtration and calcium removal prior to ion exclusion.

ION EXCLUSION PURIFICATION OF MOLASSES
J. B. Stark

Static columns of 50 to 100 mesh Dowex-50WX4(k) were used to recover sucrose from beet and cane molasses, and invert from cane molasses. Operation at 90°C appeared to give the best overall separation, the highest concentration of solids, and the most stable products.

LIMING OF SUGAR BEET COSSETTES
Alan E. Goodban and R. M. McCready

Cossette preliming at low temperature permits alkaline diffusion without disintegration of the pulp. The diffusion juice contains very little colloidal material, and the over-all lime used to produce clarified juice is reduced to less than 1 percent on beets. The preliming must be carried out below 40°C. and sufficient time (5 to 10 minutes) must be allowed for the pectin to be stabilized before the cossettes are subjected to heat. Acetate ion is produced by alkaline treatment of cossettes, and about 0.1 percent Na_2CO_3 on beets is required to control lime salts. Advantages of the process are reduced lime consumption, extension of permissible temperature range for diffusion, and the production of diffusion juice suitable for direct ion exchange treatment.

Biochemical Studies

ACCUMULATION OF NON-SUCROSE CARBOHYDRATES DURING STORAGE OF SUGAR BEETS

R. M. McCready and J. C. Goodwin

Sugar beets were stored under optimum conditions at 2°C. for a period of up to 115 days. The changes in sucrose, reducing sugars, raffinose, and kestose were followed. Beets stored for 86 days at 2°C. were returned to storage at 25°C. for 2 weeks and further changes in the carbohydrates were followed.

Composition Studies

BEET MOLASSES PURITY PREDICTIONS FROM THIN JUICE CHLORIDE ANALYSES

J. B. Stark

Chloride analyses of thin or thick juice are useful in predicting changes in molasses purity. They should also be useful in evaluating certain processing characteristics (purity and amount of molasses) of beets grown under different soil and water salinities.

COMPOSITION OF BEET MOLASSES

Part I. MOLASSES COMPOSITION. J. B. Stark

Beet molasses from 33 factories were analyzed. Slight differences were found between straight house and Steffen molasses. The latter averaged slightly higher in raffinose and lower in nitrogen compounds. Differences due to the raw material were greater than those due to processing.

Part II. MOLASSES PURITY AND COMPOSITION. J. B. Stark, M. Sandomire, and R. M. McCready

Straight house molasses chloride content was the only composition variable positively correlated with purity. All nitrogen fractions except nitrate were negatively correlated with purity. The correlations between composition and Steffen molasses purity probably do not represent the melassigenic character of the impurities.

THE OSMOLALITY OF SUGAR BEET PRESS JUICE

A. E. Goodban and R. M. McCready

The osmotic concentration of press juice from individual beets was measured and compared with the sugar content. The osmotic concentration has a relatively small range of variation compared to sugar concentration. The indication of a narrow range of osmotic concentration in beet press juice implies that low molecular weight non-sugars may have a profound effect on the storage of sugar in beet roots.

SUGAR BEET AND PURIFIED JUICE QUALITY IN RELATION TO NON-SUGAR CONSTITUENTS

R. M. McCready, A. E. Goodban, Rachel Ratner (Technion, Israel Inst. of Technol.) Alber Ulrich (Univ. of Calif., Berkeley)

Beets grown in the same field, selected for high and low petiole nitrate contents and size within each population were processed into brei, pressed juice, and purified juice. Sugar and non-sugar constituents and some of their effects and interactions on juice quality were determined. Correlations between some constituents of the beets, pressed juice, and purified juice were highly significant.

PREPARATION OF GALACTINOL AND MYOINOSITOL FROM SUGAR BEET SIRUP BY CHROMATOGRAPHY ON AN ION EXCHANGE RESIN

R. M. McCready, J. B. Stark, and A. E. Goodban

Sugar beet sirup enriched in galactinol and myoinositol by special processing procedures was fermented, oxidized, ion-exchanged, and passed through an ion-exclusion column. Appropriate fractions were collected and evaporated. Galactinol and myoinositol were crystallized in pure form and some of their physical and crystal properties are described.

SOME SUBSTANCES ADSORBED ON GRANULAR CARBON FROM BEET THICK JUICE

H. G. Walker, Jr. and R. M. McCready

Samples of granular carbon used for purification of beet thick juice were obtained from 3 different beet processing areas. These samples were eluted and analyzed for carbohydrates and other constituents.

THIN-LAYER CHROMATOGRAPHY OF SUGAR BEET CARBOHYDRATES

H. G. Walker, Jr., B. A. Ricci, and J. C. Goodwin

J. Amer. Soc. Sugar Beet Technol., in press

The use of thin-layer chromatography to separate fructose, glucose, sucrose, kestose, raffinose, and galactinol in beet juices is described. The method is recommended as an alternative to paper chromatography for rapid qualitative analysis of the carbohydrates in sugar beet juices.

Sugar Research

ISOLATION OF 1-KESTOSE AND NYSTOSE BY CHROMATOGRAPHY ON A CATION EXCHANGE RESIN

R. M. McCready and J. C. Goodwin

J. Chromatog., in press

The oligosaccharides 1-kestose and nystose were separated from an oligosaccharide mixture on ion exchange columns using 200 to 400 mesh Dowex 50WX4(k).

POLYSACCHARIDES OF SUGAR BEET PULP

R. M. McCready

Some 1,000,000 tons of dried sugar beet pulp are potentially available as an inexpensive and stable source material for chemical utilization. Four carbohydrates, pectin 25 percent, cellulose 25 percent, araban 20 percent, and galactan 6 percent, make up the bulk of this material. The chemistry of some of these carbohydrates is reviewed.

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